Generating the Dual-mode Vortex Electromagnetic Wave by Designing and Analysing of Dual-band Antenna Array

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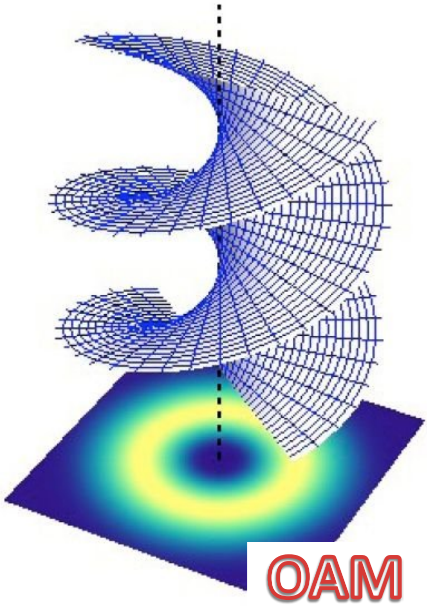
Xidian University

16/10/2017



OUTLINE

- Introduction
- Generation Methods
- Dual-mode Antenna Array
- Conclusions

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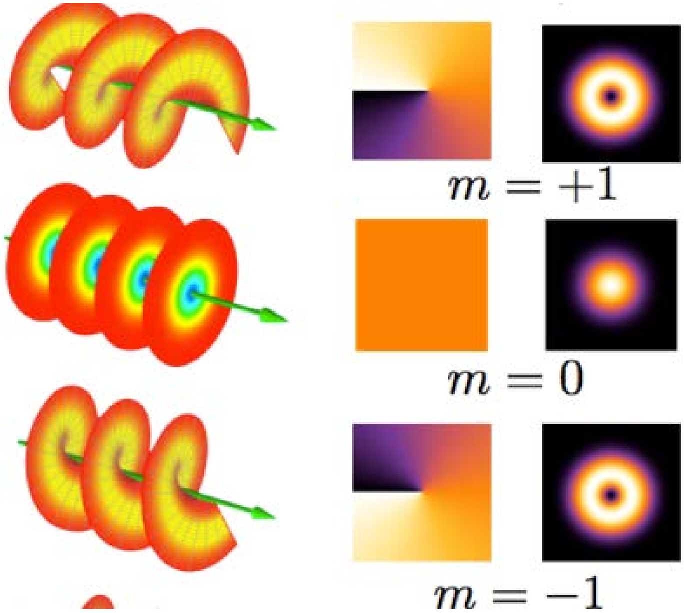
1 Introduction

Concept

➢**Orbital Angular Momentum (OAM), or Vortex Electromagnetic Wave: .**

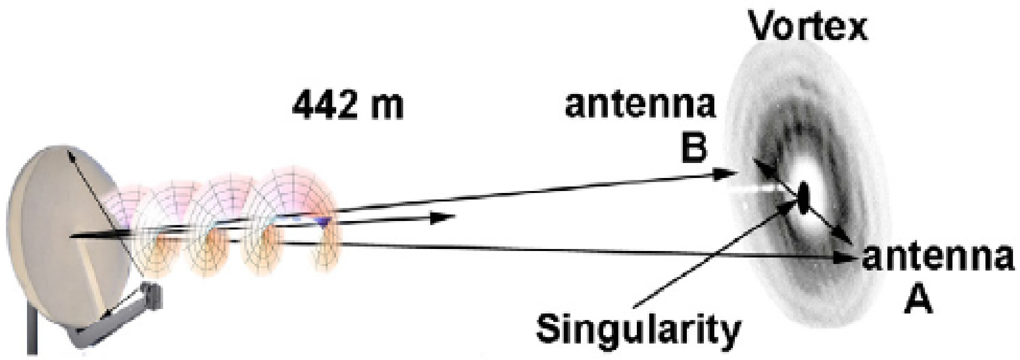
- ◆ **Magnitude: Vortex Distribution**
- ◆ **Phase： Spiral Phase**

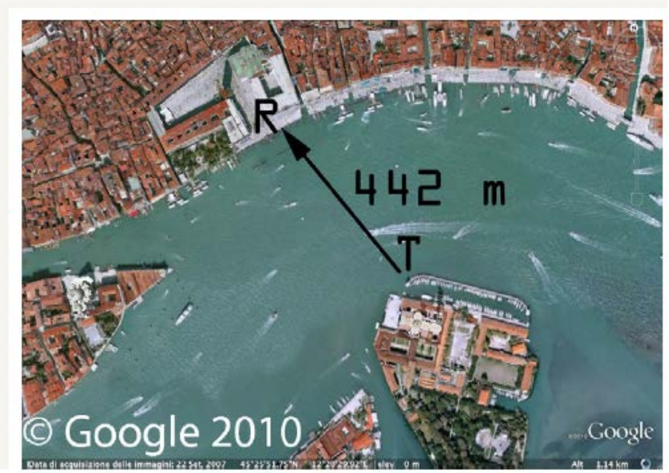


1 Introduction

Applications

- **Appling electromagnetic vortex in wireless communication is achievable.**


442 m
antenna B
Vortex
antenna A
Singularity


R
442 m
T
© Google 2010
Google

Tamburini F, et al. New Journal of Physics, 14(3): 033001, 2012.

- **Benefits:**

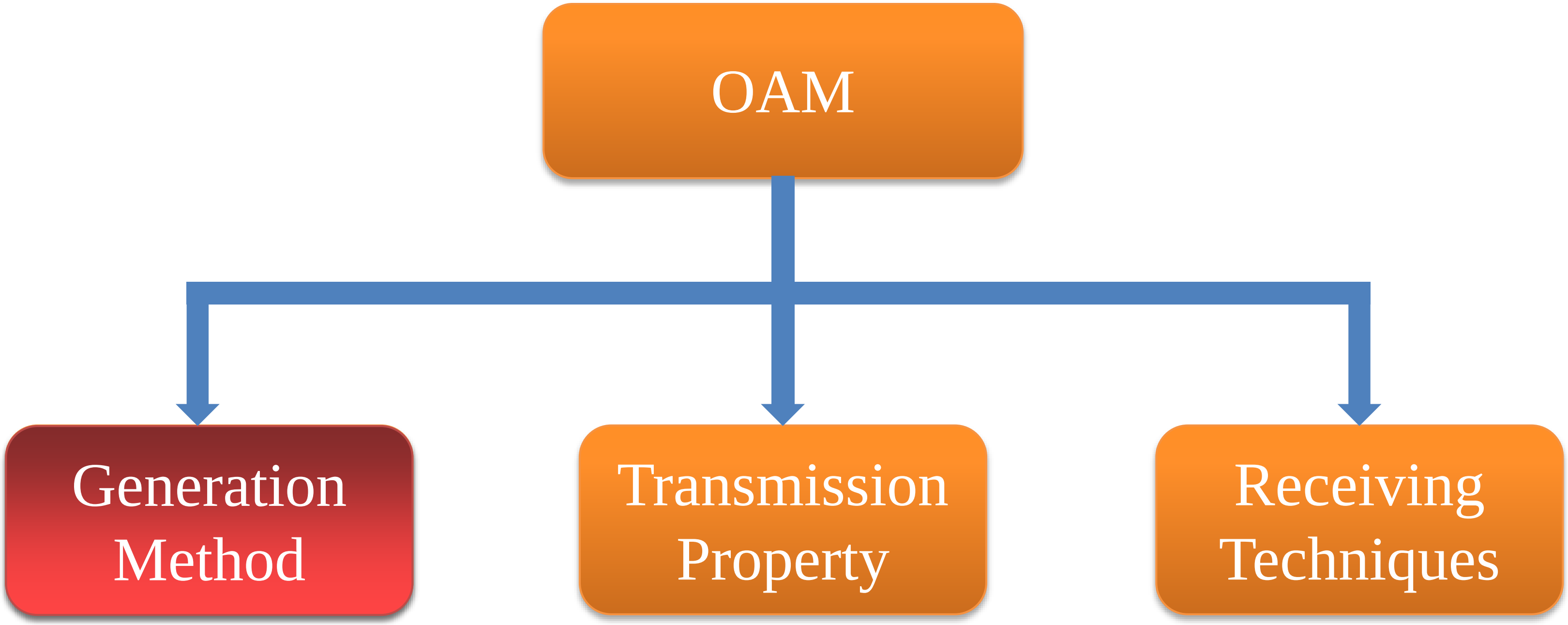
The system's capacity improvement ;

A novel multiplexing resource;

Theoretical numerous othogonal OAM state modes.

1 Introduction

Research Focus



OAM

Generation Method

Transmission Property

Receiving Techniques

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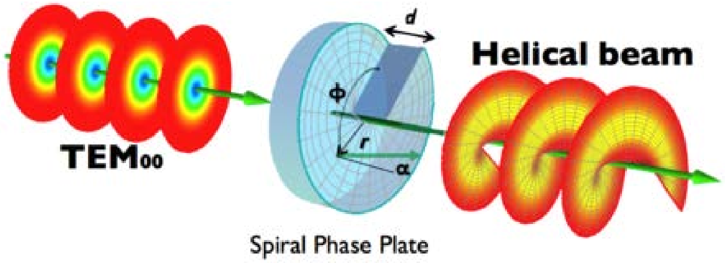
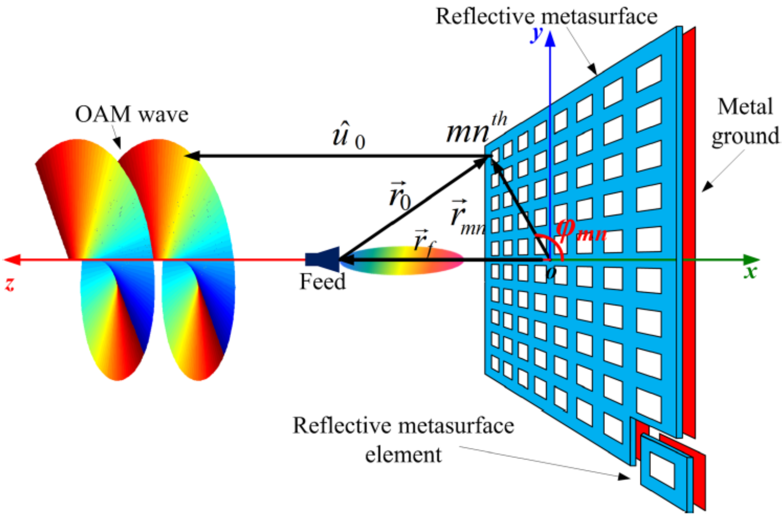
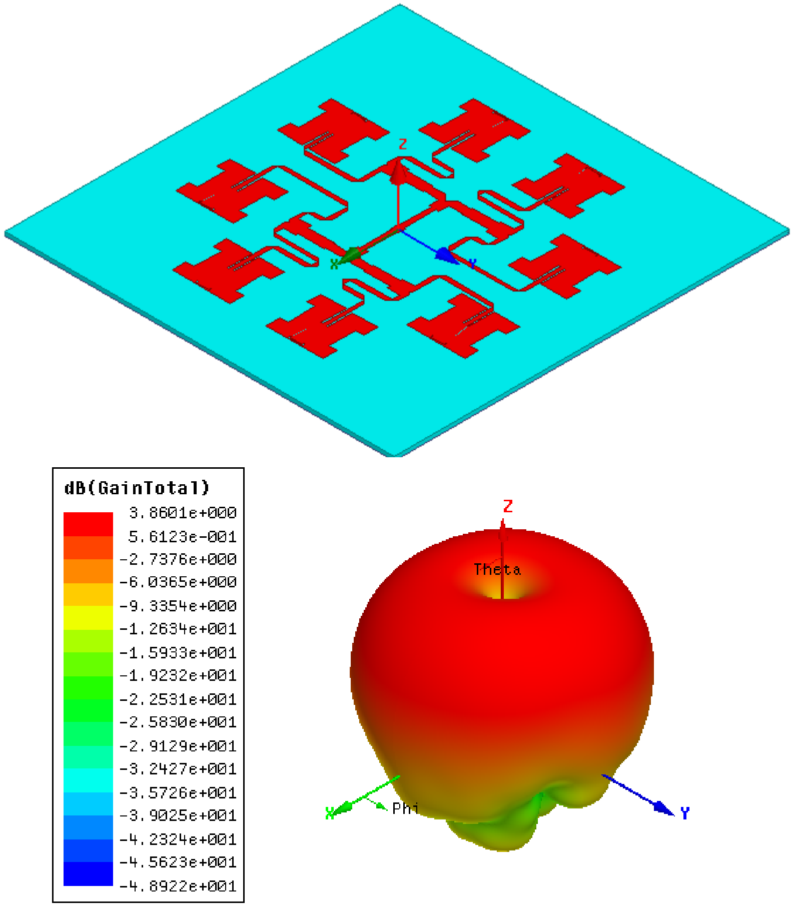
2 Generation Methods


Helical beam
TEM00
d
Φ
r
α
Spiral Phase Plate

Spiral Phase Plate


Reflective metasurface
y
OAM wave
$\hat{u}_0$
mn^{th}
Metal ground
$\vec{r}_0$
$\vec{r}_{mn}$
φ_{mn}
$\vec{r}_f$
z
Feed
o
x
Reflective metasurface element

Metasurface


z
x
y
dB(GainTotal)
3.8601e+000
5.6123e-001
-2.7376e+000
-6.0365e+000
-9.3354e+000
-1.2634e+001
-1.5933e+001
-1.9232e+001
-2.2531e+001
-2.5830e+001
-2.9129e+001
-3.2427e+001
-3.5726e+001
-3.9025e+001
-4.2324e+001
-4.5623e+001
-4.8922e+001
Z
Theta
X
Phi
Y

Antenna Array

2 Generation Methods

OAM Antenna Array Design:

Array Layout

Feeding Network

Performance Improvements:

Working Bandwith

The Number of OAM State Mode

Aperture’s Utilization

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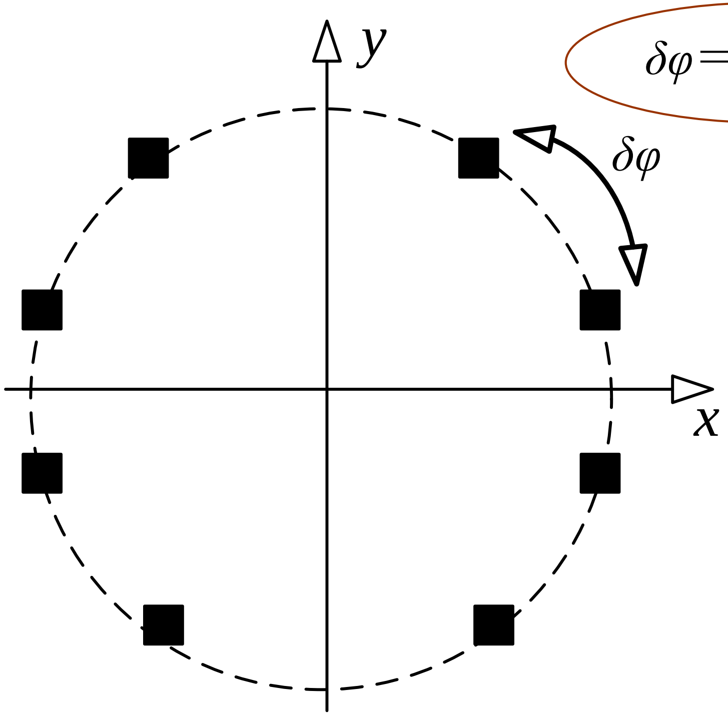
3 Dual-mode Antenna Array

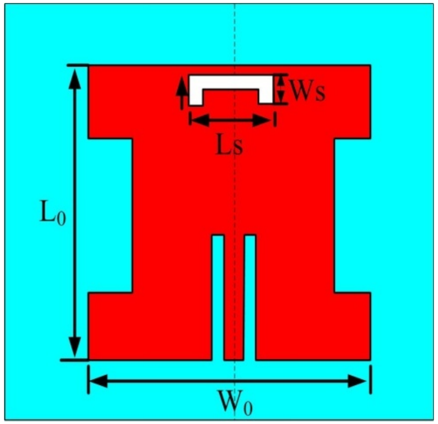
Array Design

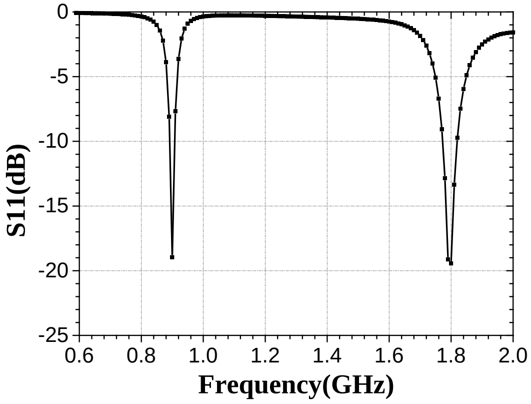


$\delta\varphi = 2\pi l/N$

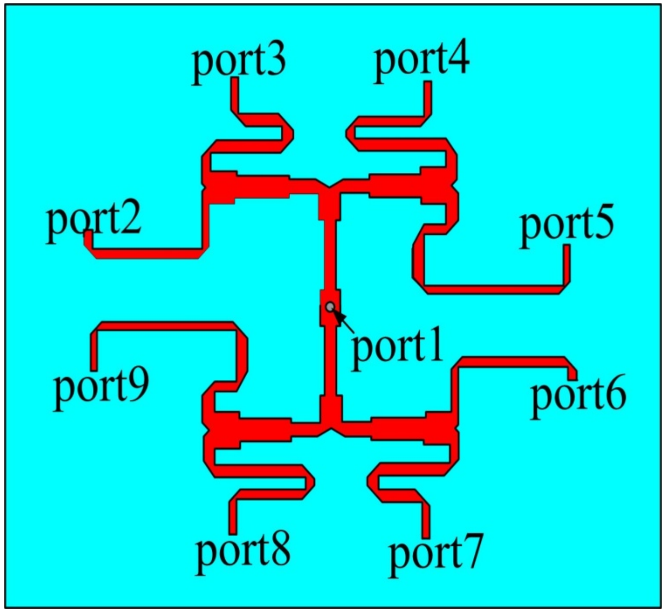
3 Dual-mode Antenna Array

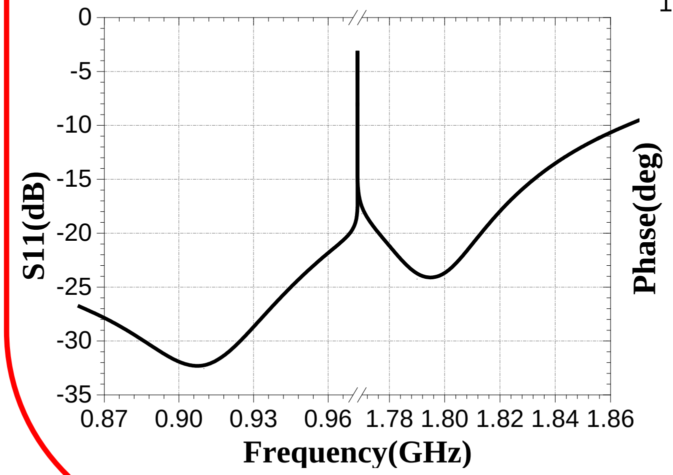
Array Design

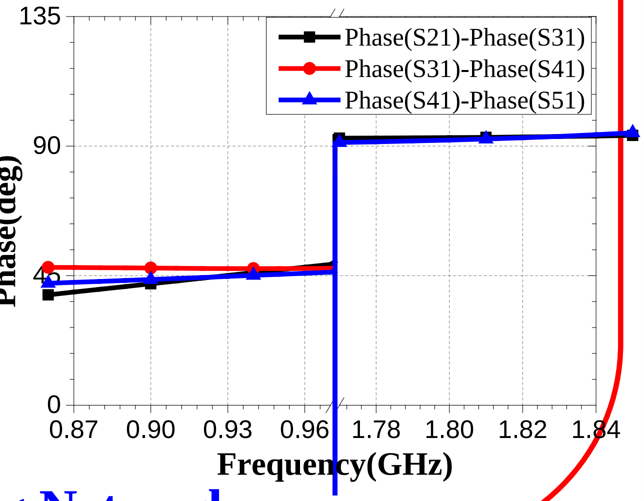




Array Unit


port3
port4
port2
port5
port1
port9
port6
port8
port7

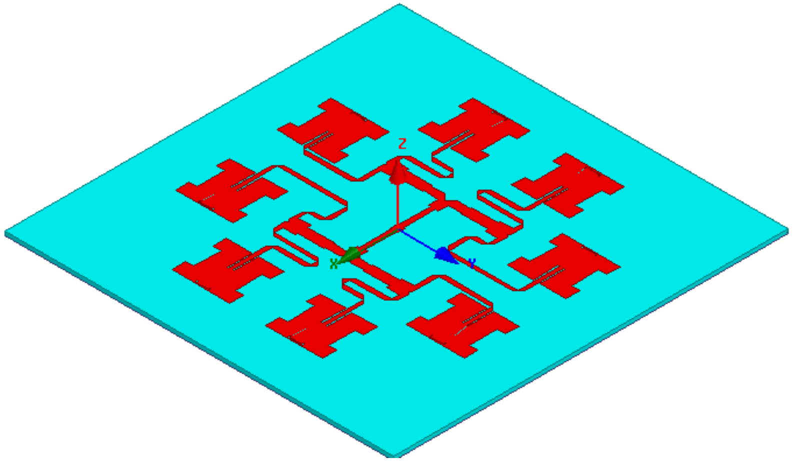




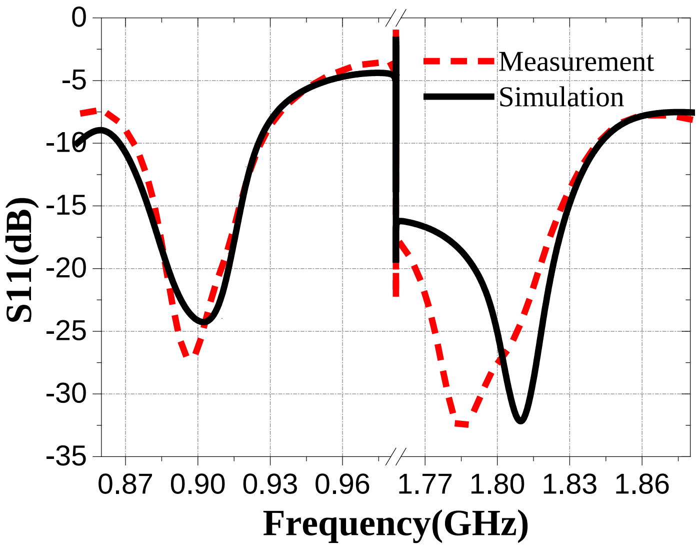
Feeding Network

3 Dual-mode Antenna Array

Array Design



Antenna Array model

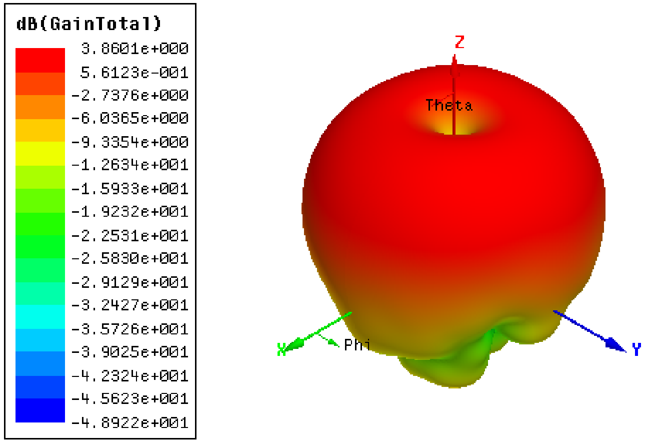


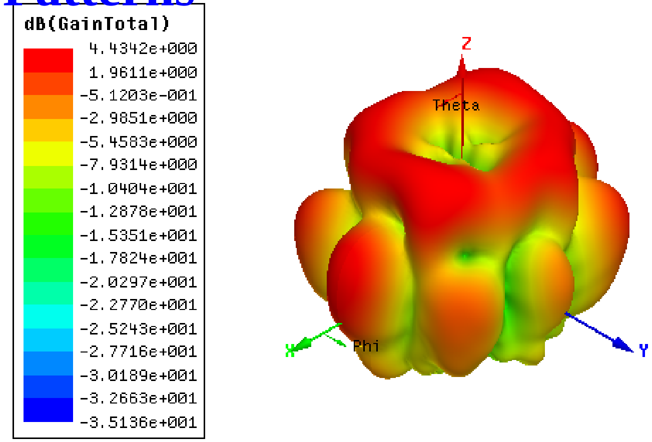
The simulated and measured S11 of antenna array

3 Dual-mode Antenna Array

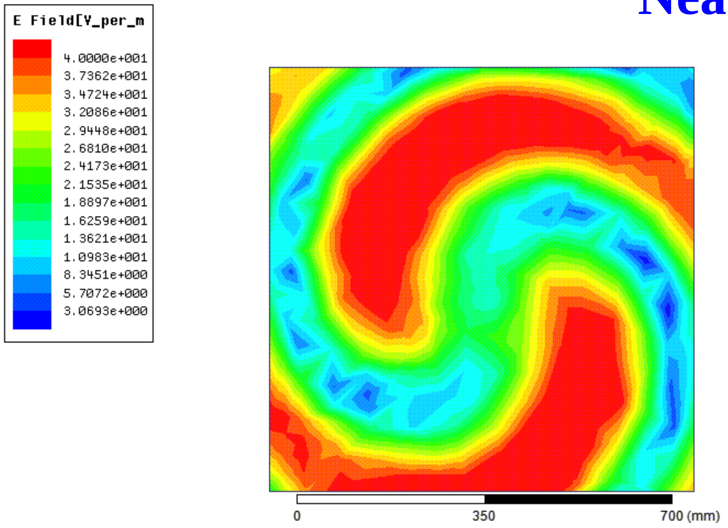
Simulation

Far-Field Patterns

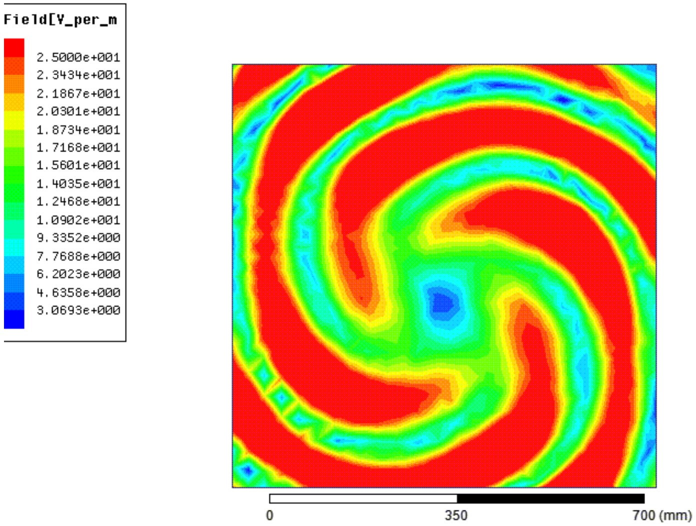




Near-field Vector E-field



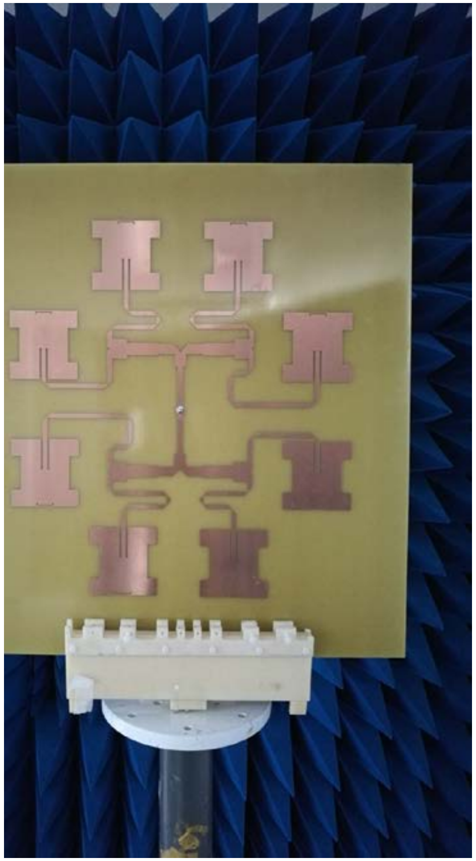
0.9GHz l=1



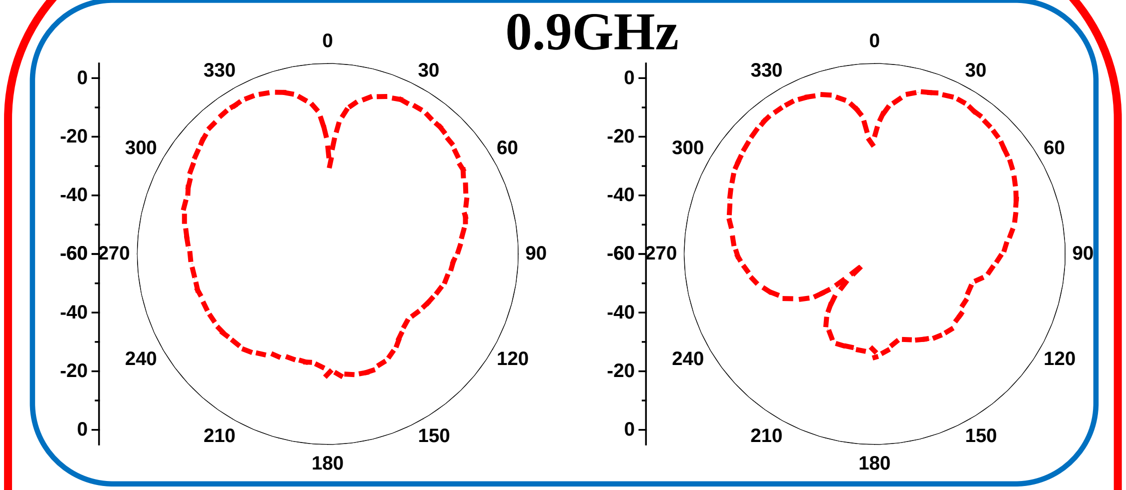
1.8GHz l=2

3 Dual-mode Antenna Array

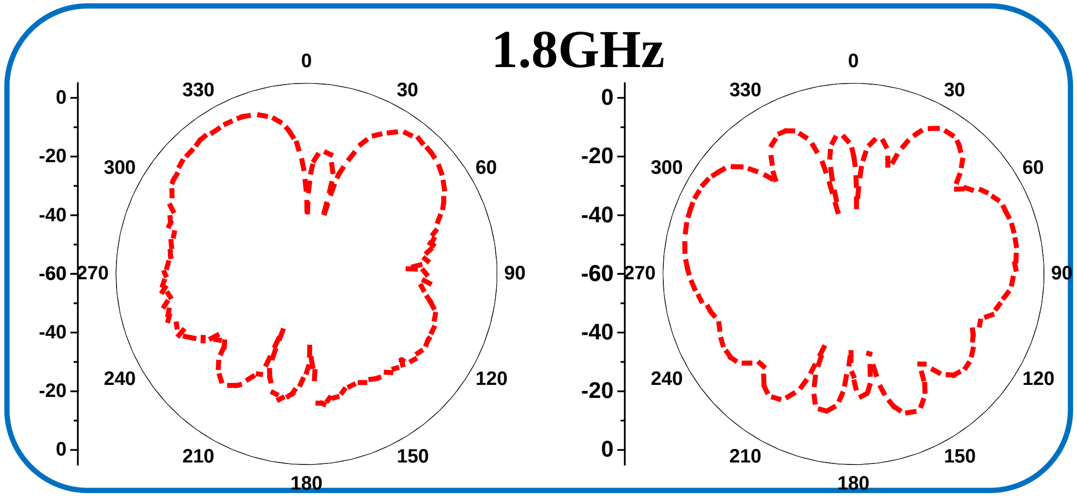
Experiment



0.9GHz



1.8GHz



E-Plane
(xoz Plane)

H-Plane
(yoz Plane)

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4 CONCLUSIONS

➢The vortex electromagnetic wave generator composed of 8-unit antenna array is designed, fabricated, and measured.

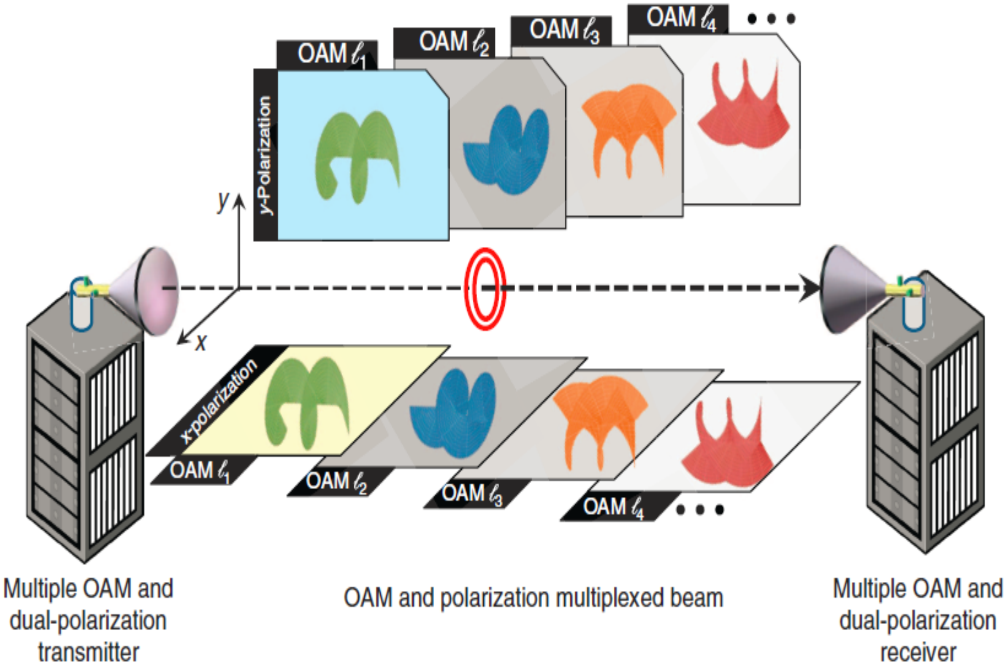
1. Dual-band differential phase feeding network

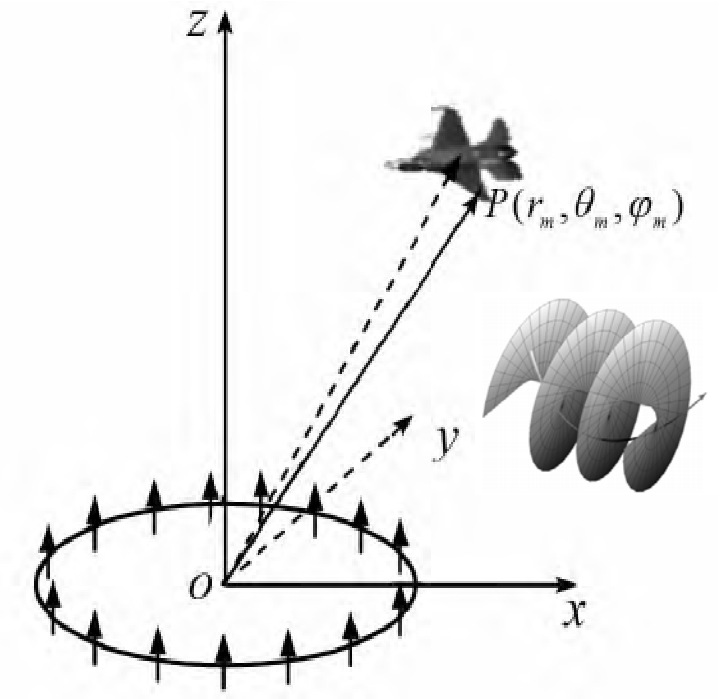
2. Dual-mode OAM wave

3. Dual-band OAM antenna array

4 CONCLUSIONS

➢**Electromagnetic Vortex is the new resource for the communication system expect for the frequency, amplitude and polarization.**


OAM ℓ_1
OAM ℓ_2
OAM ℓ_3
OAM ℓ_4
• • •
y-Polarization
y
x
x-polarization
OAM ℓ_1
OAM ℓ_2
OAM ℓ_3
OAM ℓ_4
• • •
Multiple OAM and dual-polarization transmitter
OAM and polarization multiplexed beam
Multiple OAM and dual-polarization receiver


z
$P(r_m, \theta_m, \varphi_m)$
y
O
x

Wireless Communication system

Radar Detection

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NewScientist

Twisted Light

It's fast, furious and perfect for talking to aliens

Animal Minds

The amazing truth

Respect for fish
Monkeys and Machiavelli
Betty, the engineer crow
Smart sheep or woolly robots?
The friendly hyena
Dogs that speak Human

Thank You!